Snow Droughts in the Northern Sierra Nevada

December 2015

January 2017

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Defining snow drought

Recent years of **below average snowpack** but **above average precipitation** (particularly in Pac NW) have motivated study of "snow droughts"
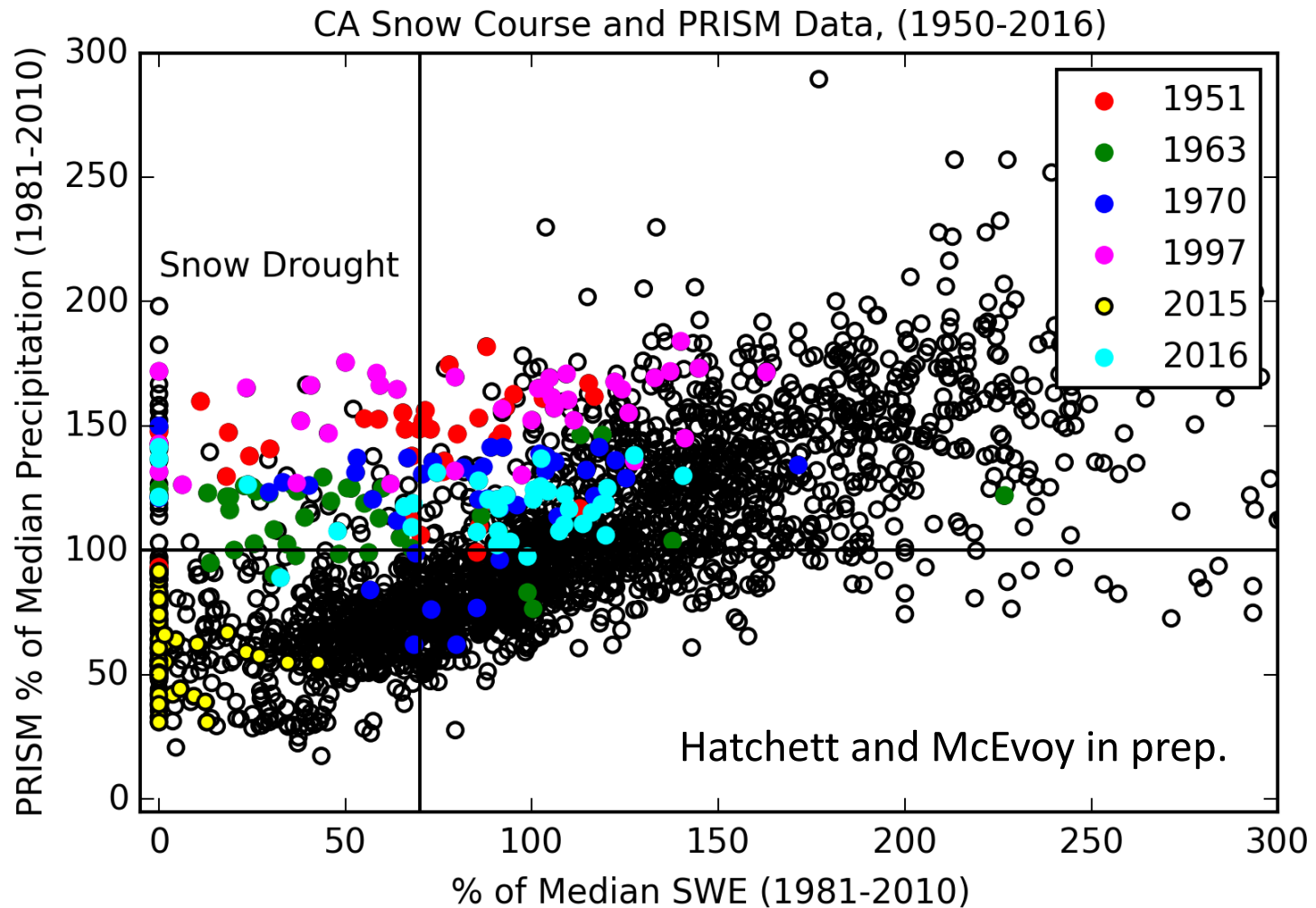
Emerging definition: At April 1, a snow drought requires **<60% snow water equivalent** AND **>100% precipitation** for the water year.

**Study area:
Northern Sierra Nevada**
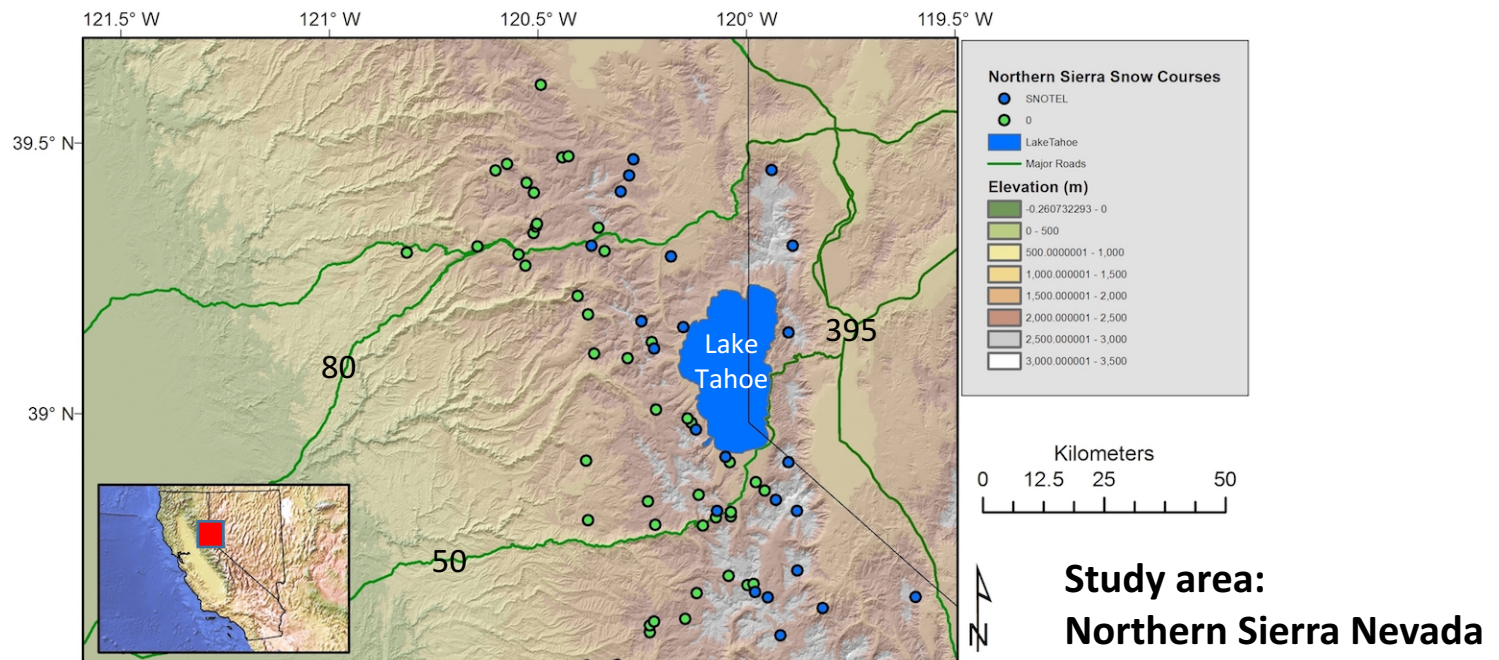
Definition is key to assessing impacts of snow droughts on hydrology and ecology of snow-dominated watersheds during the cool season and subsequent warm season.

Examples of snow droughts in the northern Sierra Nevada
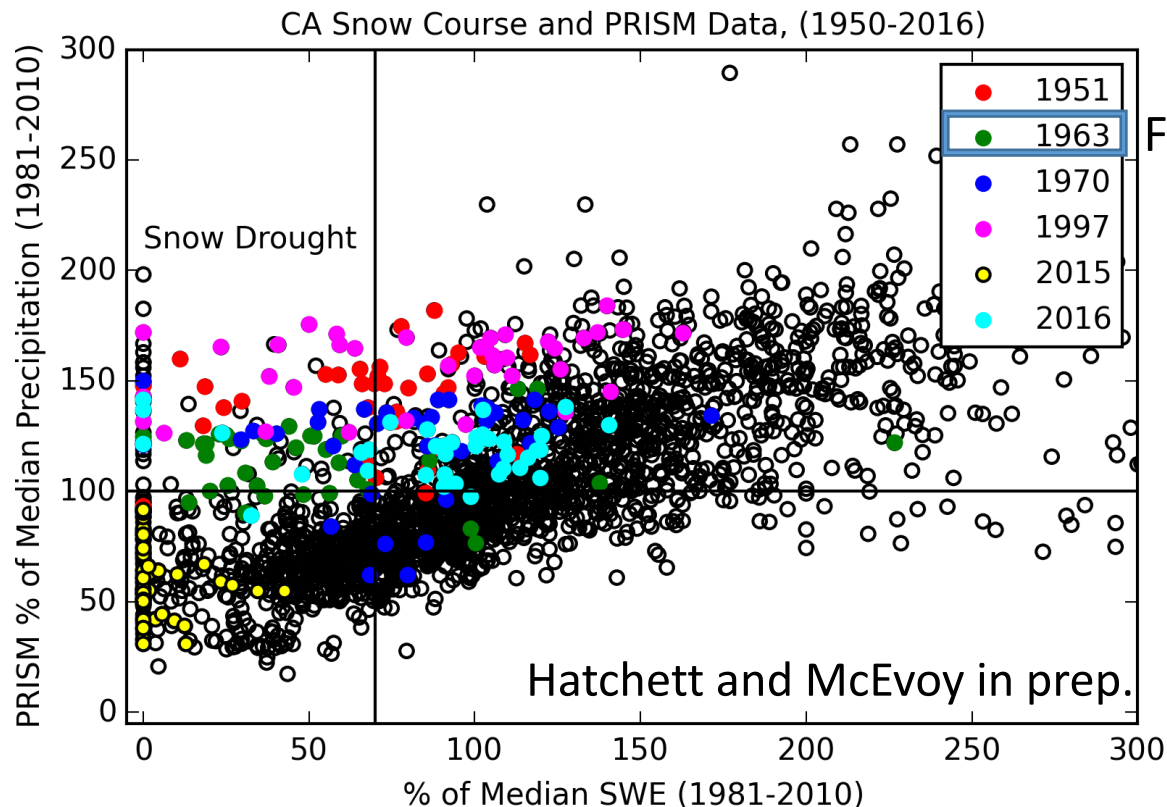

CA Snow Course and PRISM Data, (1950-2016)

Snow Drought

Hatchett and McEvoy in prep.

Legend: 1951, 1963, 1970, 1997, 2015, 2016

Y-axis: PRISM % of Median Precipitation (1981-2010)
X-axis: % of Median SWE (1981-2010)

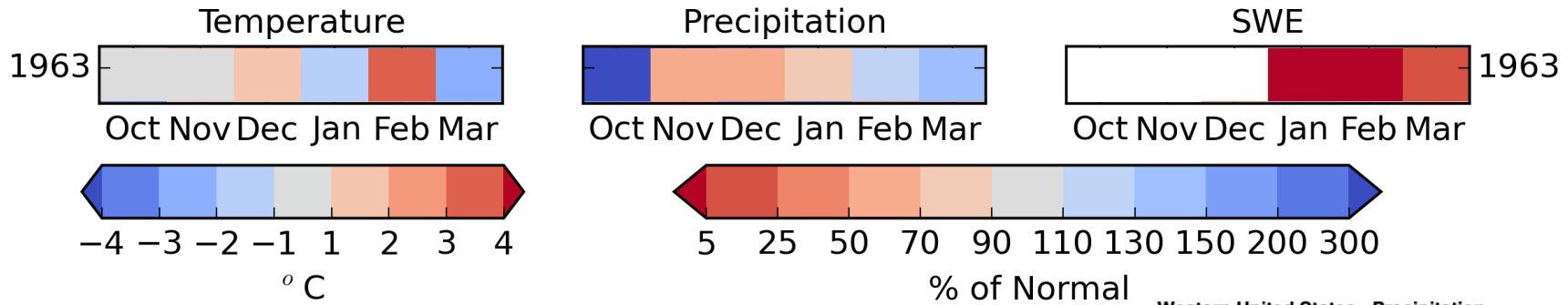# A few problems exist with the April 1 definition…

1. **Singular events (especially early in the season) can skew results. Case study: 1963**

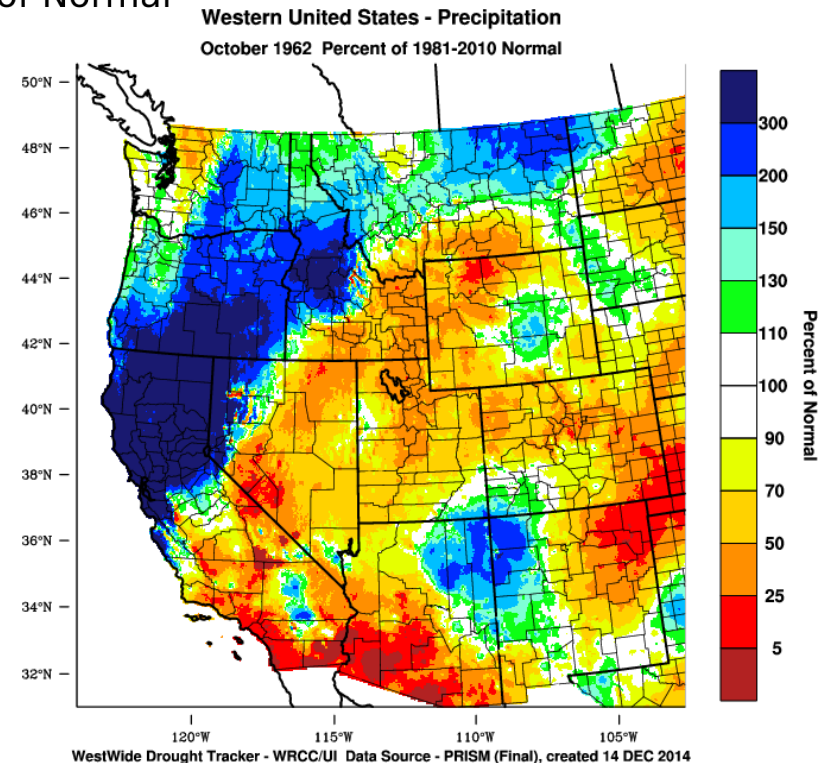CA Snow Course and PRISM Data, (1950-2016)

Focus on WY 1963

Legend: 1951, 1963, 1970, 1997, 2015, 2016

Snow Drought

Hatchett and McEvoy in prep.

PRISM % of Median Precipitation (1981-2010)

% of Median SWE (1981-2010)

Thus it is valuable to check how a season unfolded (part I)

Temperature

1963

Oct Nov Dec Jan Feb Mar

−4 −3 −2 −1 1 2 3 4
^{o} C

Precipitation

Oct Nov Dec Jan Feb Mar

SWE

1963

Oct Nov Dec Jan Feb Mar

5   25   50   70   90 110 130 150 200 300
% of Normal

An exceptionally wet and warm storm during October drove positive water year precipitation anomalies while the rest of the year was near normal.

Warm, wet February helped keep SWE low with some recovery in March.

Western United States - Precipitation
October 1962 Percent of 1981-2010 Normal

Percent of Normal
300
200
150
130
110
100
90
70
50
25
5

WestWide Drought Tracker - WRCC/UI Data Source - PRISM (Final), created 14 DEC 2014

A few problems exist with the April 1 definition…

1. Singular events (especially early in the season) can skew results

2. **Using a single time means you only see one state of the system. Case study: 2016**

CA Snow Course and PRISM Data, (1950-2016)

Focus on WY 2016

Legend:
- 1951 (red)
- 1963 (green)
- 1970 (blue)
- 1997 (magenta)
- 2015 (yellow)
- 2016 (cyan)

Snow Drought

Hatchett and McEvoy in prep.

y-axis: PRISM % of Median Precipitation (1981-2010)
x-axis: % of Median SWE (1981-2010)
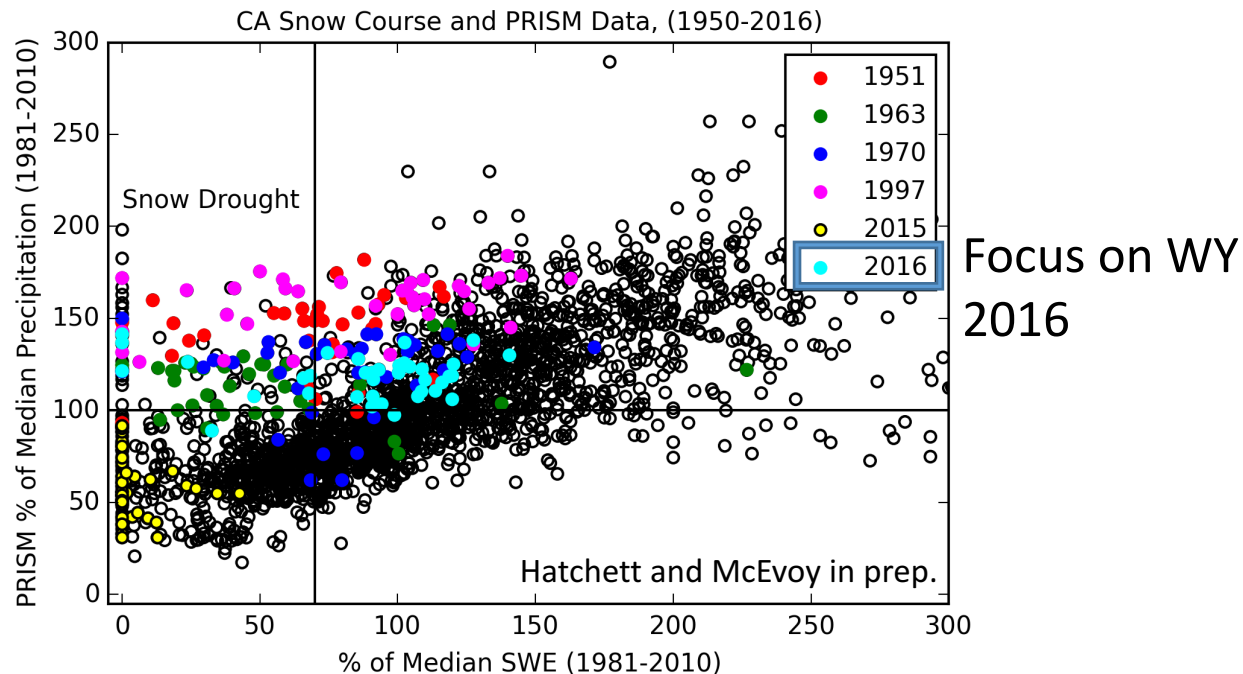
Thus it is valuable to check how a season unfolded (part II)

Tahoe City SNOTEL (elev. 2072 m)

Legend:
- 2016 SWE
- 1981-2010 Median SWE
- Precipitation (PPT)
- Accumulated Precipitation
- 1981-2010 Median PPT Accumulation

Hatchett and McEvoy in prep.

Above median PPT and SWE through Jan

Onset of snow drought during dry/warm Feb.

Below median SWE but above median PPT at Apr 1

Warm nature of March storms muted SWE recovery

April 1

Y-axis: SWE (mm/2); PPT (mm); Accum PPT (mm/6)
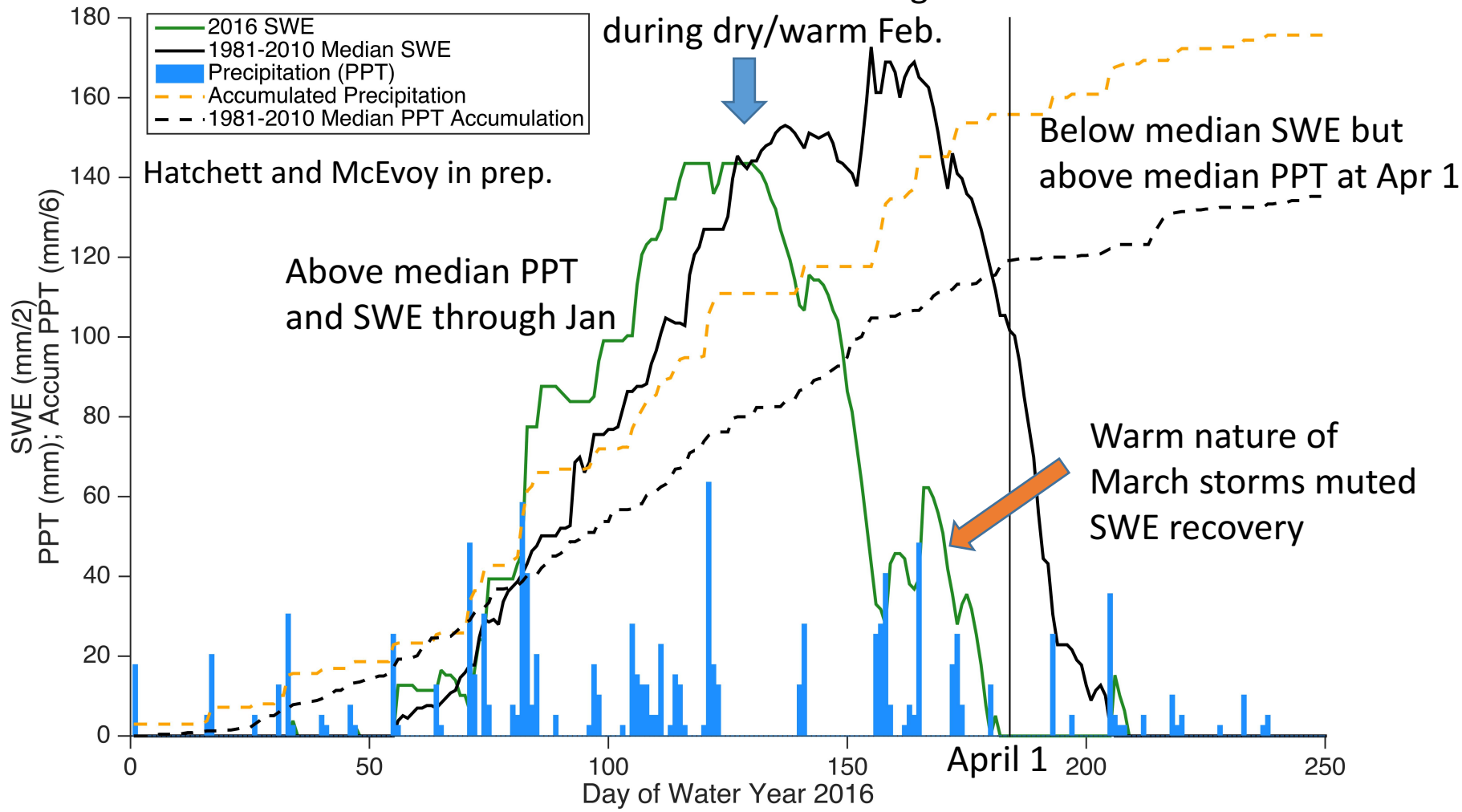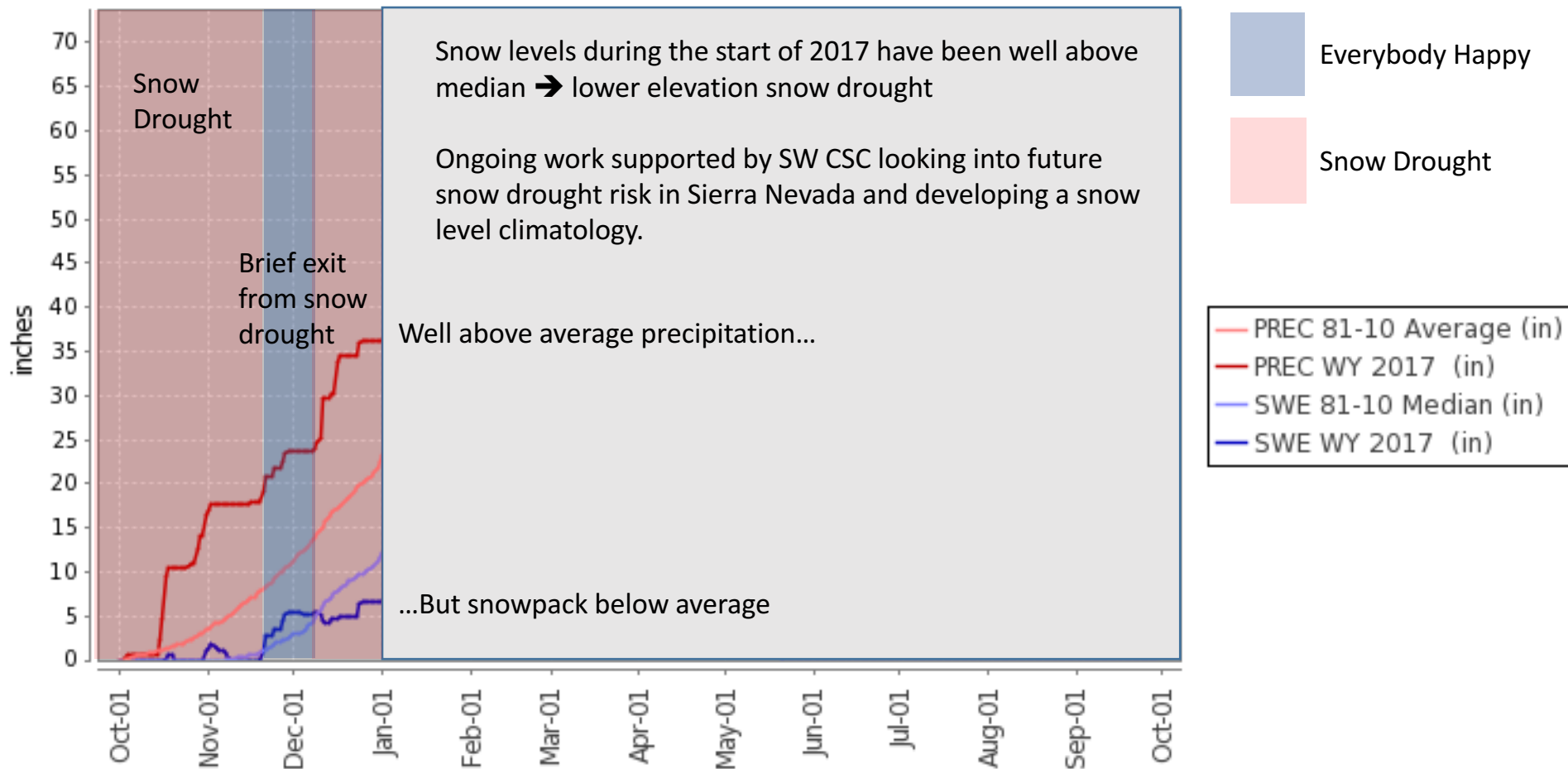X-axis: Day of Water Year 2016

A few problems exist with the April 1 definition...

1. Singular events (especially early in the season) can skew results

2. Using a single time means you only see one state of the system:

3. **Using a single time means potentially missing the 'story' of snow drought evolution and its impacts during the winter**
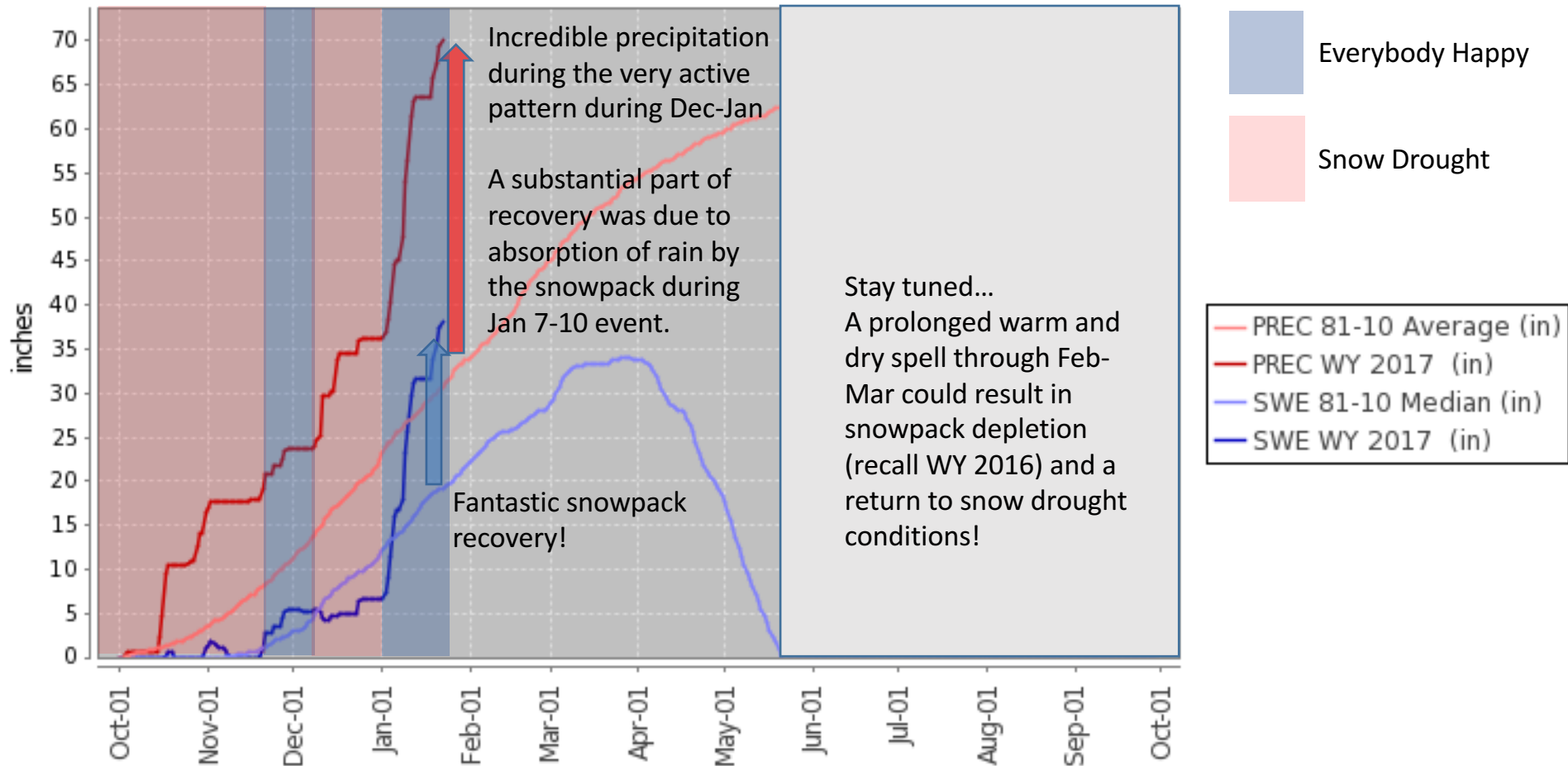
Case study 2017:
Onset and Termination

Station (428) WATERYEAR=2017 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Mon Jan 23 08:22:25 GMT-08:00 2017

Snow Drought

Brief exit from snow drought

Snow levels during the start of 2017 have been well above median ➔ lower elevation snow drought

Ongoing work supported by SW CSC looking into future snow drought risk in Sierra Nevada and developing a snow level climatology.

Well above average precipitation...

...But snowpack below average

Everybody Happy

Snow Drought

— PREC 81-10 Average (in)
— PREC WY 2017 (in)
— SWE 81-10 Median (in)
— SWE WY 2017 (in)

Case study 2017:
Onset and **Termination**

Station (428) WATERYEAR=2017 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
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Incredible precipitation during the very active pattern during Dec-Jan

A substantial part of recovery was due to absorption of rain by the snowpack during Jan 7-10 event.

Fantastic snowpack recovery!

Stay tuned...
A prolonged warm and dry spell through Feb-Mar could result in snowpack depletion (recall WY 2016) and a return to snow drought conditions!

Everybody Happy

Snow Drought

PREC 81-10 Average (in)
PREC WY 2017 (in)
SWE 81-10 Median (in)
SWE WY 2017 (in)

Concluding Remarks

1. Snow drought definition still somewhat arbitrary
2. Exploring the hydrometeorological origins of snow droughts provides insight into process/impacts
3. A few storms or a persistent dry (wet) period can play an important role in snow drought onset (termination)
4. Need for real-time monitoring?

Thanks!
Now Back to Fieldwork!

We'd love to hear your
thoughts on all things snow drought.

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photo by Josh Hejl